DOCUMENT RESUME

ED 047 715 LI 002 575

AUTHOR	Crum, Norman J.
TITLE	Cost-Benefit and Cost-Effectiveness Analyses: A Bibliography of Applications in the Civilian Economy.
INSTITUTION	General Electric Co., Santa Barbara, Calif.
REPORT NO	69TMP-30
PUB DATE	11 Apr 69
NOTE	28p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	*Bibliographies, Communication (Thought Transfer), *Cost Effectiveness, Economics, Information Processing, *Information Science, *Information Services, Resource Allocations
IDENTIFIERS	*Planning Prcgramming Budgeting Systems (PPBS)

ABSTRACT

This annotated and preliminary bibliography emphasizes applications of cost-effectiveness (C/E) and cost-benefit (C/B) analyses to problems in the civilian economy. The entries are organized so that the user may identify works in which these techniques are applied to problems in specific areas such as transportation, ccmmunication, and health. No attempt has been made to include basic books on the theory of the subject, articles describing limitations of these techniques or methods, or discussions on costing and problems of establishing effectiveness criteria that do not combine these two study elements. C/B and C/E techniques are closely related to planning-programming-budgeting (PPB) and a host of other resource-allocation methods. Entries involving these subjects are included cnly when they emphasize application of C/B or C/E techniques. With a few exceptions, military-oriented references are excluded. Because of their broad coverage, including studies which may be useful in solving problems in the civilian economy, the most relevant volumes from Defense Documentation Center compilations are cited. (Author/AB)

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COST-BENEFIT AND COST-EFFECTIVENESS ANALYSES: A BIBLIOGRAPHY OF APPLICATIONS IN THE CIVILIAN ECONOMY

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69TMP-30
11 April 1969

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LI 002575

FOREWORD

This bibliography was prepared under General Electric TEMPO Development Authorization Number 1308122. It is one of the continuing efforts by TEMPO's Technical Information Center to serve the Professional Staff.

An increasing need has been expressed by that staff for a convenient listing of representative cost-effectiveness (C/E) and cost-benefit (C/B) application studies. Awareness of the need for and interest in such a compilation are shared with such professional groups as the C/E Section of the Operations Research Society of America. Mr. Harry Hatry, a former TEMPO staff member and former Chairman of the C/E Section of ORSA, several years ago recognized the need for such control of the literature.

This work provides the nucleus for a more comprehensive work. Based on a highly selective and limited number of references, its format only suggests one of the possible alternatives. Suggestions for improvements in structuring the materials for more effective use will be appreciated.

David S. Fields
Member, TEMPO Professional Staff

April 1969
Santa Barbara, California

INTRODUCTION

This annotated and preliminary bibliography emphasizes applications of cost-effectiveness (C/E) and cost-benefit (C/B) analyses to problems in the civilian economy. The entries are organized so that the user may identify works in which these techniques are applied to problems in specific areas such as transportation, communication, and health. No attempt has been made to include basic books on the theory of the subject, such as those written by Charles Hitch and Roland McKean, articles describing limitations of these techniques or methods, per se, or discussions on costing and problems of establishing effectiveness criteria that do not combine these two study elements. Exclusion of these works is not meant to minimize their importance to the popularization and development of the subject. In achieving the present selection, a considerable amount of this other literature has been scanned and documented elsewhere.

C/B and C/E techniques are closely related to planning-programming-budgeting (PPB) and a host of other resource-allocation methods. Entries involving these subjects, however, are included only when they emphasize application of C/B or C/E techniques. With a few exceptions, military-oriented references are excluded. Because of their broad coverage, including many studies which may be useful in solving problems in the civilian economy, the most relevant volumes from the Defense Documentation Center compilations are cited.

This bibliography does not pretend to cover a substantial portion of all works on this subject. It does, however, include representative works in each of the 11 major application areas around which it is organized.

The arrangement is largely alphabetically by the major application area, e.g., COMMUNICATIONS, except for three instances. Bibliographies are given in the first category since these may be useful in seeking out additional sources of information. When a publication deals with a variety of applications, it is listed within the second category SEVERAL APPLICATIONS. The last category MISCELLANEOUS APPLICATIONS includes a variety of application areas wherein only an item or two were found for inclusion.

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BIBLIOGRAPHIES

Harvey, Ann. "1966 Periodical Articles on Cost-Effectiveness." *C-E Newsletter*, Cost-Effectiveness Section, Operations Research Society of America, March 1967, vol. 2, pp. 4-5.

A list of about 50 briefly annotated articles on cost-effectiveness that appeared in 1966.

Public Management Sources (periodical). Bureau of the Budget Library/Executive Office of the President.

Most issues include references to some writings on cost-benefit analysis.

Research Analysis Corporation. *Bibliography on Cost-Benefit Analysis and Planning-Programming-Budgeting* by Elizabeth H. Pearman. 44 pp. February 1966.

"The portion on cost-benefit analysis contains sections on general defense; health, education, and welfare; public investments; resource development; transportation; and urban development."*

U.S. Bureau of the Budget, Library. *Program Analysis Techniques: A Selected Bibliography,* Revised, supplement. 17 pp. Washington, D.C., 1967.

Supplements and updates a bibliography with the same title in November 1966. "New studies on cost-benefit analysis techniques and significant titles inadvertently omitted in the previous compilation have been included." Covers general applications as well as broad subject areas, e.g., community development; foreign aid; health, education, and welfare; highways; R&D; resource development; and transportation.

U.S. Bureau of the Budget, Library. *Program Analysis Techniques: A Selected Bibliography.* 33 pp. December 1965.

Identifies a number of studies related to nondefense areas: Community development and services; health, education, and welfare; highways; resource development; and transportation.

U.S. Defense Documentation Center. *Cost Effectiveness Analysis. Operations Research Series Volume 4–A Report Bibliography.* AD-379 601, 151 pp. Washington, D.C., March 1967.

A compilation of references mainly concerned with R&D decision making, management problems, design tradeoffs, related cost estimates, and systems-value engineering. This is one of a series of Defense Document Center bibliographies on cost effectiveness and related areas. The emphasis is largely defense, and, accordingly, a number are classified.

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*Material in quotations in the annotations originates from the respective documents.

U.S. Defense Documentation Center. *A DDC Bibliography on Cost Effectiveness Analysis, Volume I.* DDC-TAS-68-14. 160 pp. plus index. Washington, D.C., August 1968. AD-675 900.

References with annotations on cost-effectiveness analysis and cost references related to cost estimation and evaluation, cost effectiveness, cost analysis and methodology in research and development, management, decision making and systems-value engineering. Contains a collection of 160 unclassified references in the Defense Documentation Center data bank that have been cataloged since 1967.

U.S. Defense Documentation Center. *A DDC Bibliography on Cost Effectiveness Analysis, Volume II.* DDC-TAS-68-15. 166 pp. plus indexes. Washington, D.C., August 1968. AD-840 900.

Same as Volume I in scope and content. However, this volume has 166 unclassified-limited references. Volume I and Volume II are updates of Defense Documentation Center report bibliographies on cost-effectiveness analysis: AD-808 900, AD-808 901, AD-808 902, AD-379 600, AD-379 601, AD-379 602, and AD-379 603.

U.S. Tennessee Valley Authority, Division of Navigation Development. *Benefit-Cost Analysis for Water Resource Projects: A Selected Bibliography.* 105 pp. Knoxville, Tennessee, October 1967.

Published jointly with the Technical Library.

SEVERAL APPLICATIONS

Dorfman, Robert, Ed. *Measuring Benefits of Government Investments.* 429 pp. The Brookings Institution, Washington, D.C., 1965.

Papers presented at a conference held at the Brookings Institution in November 1963. The seven contexts covered are R&D expenditures, outdoor recreation projects, education programs, federal aviation expenditures, highway programs, urban renewal projects, and public health programs.

Industrial Relations Research Association. "Manpower and Welfare Programs: Benefit-Cost Analysis" in *Industrial Relations Research Association, Proceedings of 17th Annual Meeting,* Chicago, 28-29 December 1964. Madison, 1965, pp. 171-214.

Contains "Benefit-Cost Analysis of Manpower Retraining," G. Somers and E. Stromsdorfer; "Benefit-Cost Analysis of Welfare Programs," J. MacDonald; "Capital-Output Analysis of Housing Programs for Developing Nations," L. Burns.

Prest, A.R., and R. Turvey. "Cost-Benefit Analysis: A Survey," *Economic Journal,* December 1965, pp. 683-735.

"Section III deals with Particular Applications and discusses some of the detailed issues arising from the applications of cost-benefit analysis in various fields: water projects (irrigation, flood control, hydroelectric, multipurpose schemes); transport projects (roads, railways, inland waterways); land usage (urban renewal, recreation, land reclamation); and health, education, and other fields (research and development, defense)."

Washington Operations Research Council. *Cost-Effectiveness Analysis: New Approaches in Decision-Making,* edited by Thomas A. Goldman. 249 pp. Frederick A. Praeger, New York, 1967.

Thirteen papers from a Washington symposium sponsored by the Washington Operations Research Council. Chapter 9, "Cost Effectiveness Analysis for Government Domestic Programs"; Chapter 10, "Cost Effectiveness Analysis for the 'War on Poverty' "; Chapter 11, "An Analysis of Metropolitan Transportation Systems."

Washington Operations Research Council. *Analysis for Planning Programming Budgeting; The Second Cost-Effectiveness Symposium,* edited by Mark Alfandary-Alexander. 174 pp. Potomac, Maryland, 1968.

Full texts of papers presented at this symposium sponsored by the Washington Operations Research Council, 13-14 March 1967. Papers include applications of cost-benefit analysis to education, identification of hazardous highway locations, industry, and other civilian areas.

COMMUNICATIONS

Dirlam, Joe B., and Alfred E. Kahn. "The Merits of Reserving the Cost-Savings from Domestic Communications Satellites for Support of Educational Television," *Yale Law Journal,* January 1968, pp. 494-519.

Concludes that the benefits of the Ford Foundation proposal would far exceed the costs.

Federal Aviation Administration, Systems Research and Development Service. *Cost/Benefit Analysis of Televised Radar for General Aviation.* 42 pp. Washington, D.C., August 1967.

"An economic evaluation of the costs and potential benefits of broadcasting radar information to general aviation aircraft via TV relay was performed. Benefits were equated to costs of general aviation accidents that might be prevented by broadcasting weather data, area route information, or positions of other aircraft."

Gautney and Jones Communications, Inc. *Communications Study State of Mississippi, Final Report.* 165 pp. Washington, D.C., November 1967.

"One of the most significant findings of the study lies in the area of increased effectiveness and reduced costs which will result from centralization of communications services. Not unlike most other states, Mississippi agencies have attempted to solve communications problems on an individual agency basis."

Parkhill, D.F. "Economic Considerations" in *The Challenge of the Computer Utility,* pp. 121-144. Addison-Wesley Publishing Co., Reading, Massachusetts, 1966.

Includes positive and negative cost-effectiveness arguments for computer utility.

Systems Analysis and Research Corporation. *Comparative Cost Analysis of Microwave and Wire Line Radar Remoting Techniques* by John W. Drake and Robert L. Schein. 68 pp. Boston, March 1963.

"Comparison is made of the cost to the FAA, of wireline remoting of digitalized radar and beacon data (and beacon only) to air-route traffic-control centers with the costs for microwave remoting of the same information in analog form."

ECONOMIC DEVELOPMENT

Burns, Leland S. "Cost-Benefit Analysis of a Social Overhead Project for Regional Development," *Regional Science Association Papers,* European Congress, Cracow, 1965, vol. 16, pp. 155-161. 1966.

A cost-benefit analysis of the feasibility of a low-rent public-housing project in the Pine Ridge Indian Reservation is presented. The benefits isolated for measurement are (1) improved productivity, hence earnings, via increased motivation and decreased absenteeism of the rehoused work force, (2) improved school attendance with its deferred impact on income, (3) improved health with lower costs of medical care, and (4) income to the sponsoring agency in the form of rents. The benefit-cost ratio was estimated as 1.35. A socioeconomic conflict arose, however, because lower-income families were discouraged from raising their earnings in order to retain the housing.

General Electric TEMPO. *Fewer Births, Better Living* by Stephen Enke. 68TMP-34. Santa Barbara, California, September 1968.

"Various cost-benefit analyses suggest that the dollar return to governments on planned parenthood expenditures, in terms of saved welfare benefits, ranges upwards from 25 to 1. It is widely believed among many social workers that public funds to assist poor families to limit their progeny can be a more effective anti-poverty measure than any other in the long run. For those poor families that otherwise would have an additional and unwanted child within a year, birth control assistance brings some relief within 12 months."

General Electric TEMPO. *Raising Per Capita Income Through Fewer Births* by Stephen Enke. 68TMP-9. Santa Barbara, California, March 1968.

"This study analyzes, for the dynamic economy of a typical less-developed country (LDC), the significance for economic development over 30 years of gradual reductions in age-specific fertility rates (assumed to result from a government-supported birth reduction campaign)."

Marglin, Stephen A. *Public Investment Criteria: Benefit-Cost Analysis for Planned Economic Growth.* 103 pp. MIT Press, Cambridge, Massachusetts, 1967.

Explores some of the problems of formulating investment criteria for the public sector of a mixed-enterprise, underdeveloped economy (India).

RAND Corporation. *Applying Analytic Methods to Problems of Development Assistance* by J. Farmer. P-3384. 15 pp. June 1966.

Describes various approaches and shows how systems analysis and cost-benefit methods used in business and in solving defense problems can be adapted for development aid. Also suggests that methods adapted from economic analysis can be used for testing criteria for validity and for identifying the scarce resources that should be the basis for costing.

RAND Corporation. *Project Evaluation for EDA* by G.S. Fishman and D.A. Fitchett. RM-4979-EDA. 28 pp. April 1966.

"An evaluation model is developed to assist the Economic Development Administration in allocating resources among requests for financia! assistance from regions in the United States where high rates of unemployment chronically exist. The major criteria for accepting or rejecting a proposed project are the increase in flow of family income in the area because of the project, the ratio of this income increase to the cost of the project, and the project's impact on unemployment."

Smith, A.D. "Active Manpower and Redundancy Policies: Their Costs and Benefits," *International Labor Review,* January/February 1967, vol. 95, pp. 49-60.

Policies covering the redistribution of labor among regions, industries, and occupations and redundancy problems resulting from the redistribution.

United Nations, Research Institute for Social Development and Office of Social Affairs. *Cost-Benefit Analysis of Social Projects: Report of a Meeting of Experts Held in Rennes, France, 27 September-2 October 1965.* Report No. 7. Geneva, April 1966.

The following working papers and case studies were prepared for the meeting and circulated to all participants: "Some Problems of Cost-Benefit Analysis of Social Investments" by N. Scott, "Cost-Benefit Analysis in the Light of Some Work of the UNRISD on the Role of Social Factors in Development" by J. Drewnowski, "A Study of the Costs and Benefits of Measures for Substitute Permanent Employment for Persons not Competitive in the Labour Market" by B. Andersen, "Analysis of Costs and Efficiency in Relation to Social Welfare Investment" by J. Arnion, "Case Study of a Cost-Benefit Analysis of Improved Housing" by L.S. Burns, "Analysis of the Economic Effects of Housing Investment" by E. Kuminek, and "Cost-Benefit Analysis of Social Projects" by E. Rado.

United Nations, Trade and Development Board, Committee on Invisibles and Financing Related to Trade. *Consideration of the Adequacy of the Rates of Growth Achieved by the Developing Countries: Costs and Benefits of Aid; Quantitative Approach* by John Pincus. TD/B/C.3/38. 40 pp. plus 6 pp., tables. New York, February 1967.

Alternative measures of resource flows. Donors' cost approach; recipients' benefit approach.

EDUCATION

General Electric TEMPO. *Analyses of Compensatory Education in Five School Districts* by E.J. Mosbaek et. al. Volume 1: Summary 68TMP-93(I), 62 pp.; Volume 2: Case Studies 68TMP-93(II), 192 pp. Santa Barbara, California, 16 August 1968.

Report of work done under contracts HEW-05-67-55 (A Survey and Preliminary Cost-Benefit Analysis in Elementary and Secondary Education) and OEC-D-8-08042-3513 (Analyses of Compensatory Education within Schools from Five Major School Districts). Detailed findings of the first study are described in an earlier TEMPO report, *Survey and Analysis of Results from Title I for Compensatory Education.*

George Washington University, Human Resources Research Office. *Computer-Administered Instruction Versus Traditonally Administered Instruction: Economics.* 43 pp. Alexandria, Virginia, June 1967.

"Projected cost-effectiveness comparisons based on the assumption of equal effectiveness for CAI and TAI are discussed for both civilian and military instruction."

Gisser, Micha. "On Benefit-Cost Analysis of Investment in Schooling in Rural Farm Areas," *American Journal of Agricultural Economics,* August 1968, vol. 50, pp. 621-629.

"Presents a general method of estimating the benefit-cost ratio of investment in schooling and draws some inferences concerning the development in farm areas in underdeveloped countries."

Hirsch, W.Z. "Incremental Income Benefits of Public Education," *Review of Economics & Statistics,* November 1965, vol. 17, pp. 392-399.

Estimates the effects on income of education expenditures.

National Center for Educational Statistics. *Cost-Benefit Analysis of Education* by Alexander Mood and Richard Powers. TN-27. 19 pp. March 1967.

Discusses difficulties of applying cost-benefit analyses to education. The paper was presented at the Washington Operations Research Council's Cost-Effectiveness Symposium, 13-14 March 1967.

Organization for Ecomonimc Co-Operation and Development. *Budgeting, Programme Analysis and Cost-Effectiveness in Educational Planning.* 304 pp. Paris, 1968.

Papers presented at the meeting on "Budgeting, Programme Analysis and Cost-Effectiveness in Educational Planning" held in April 1968 and attended by experts from OECD countries. Primarily focused on the integration of short-run and long-run aspects of educational planning and the relationship between objectives and implementation. Also considered were the use of cost-benefit and cost-effectiveness analyses in programme planning and in resource-allocation studies.

Spiegelman, Robert G. "A Benefit-Cost Model to Evaluate Educational Programs," *Socio-Economic Planning Sciences,* August 1968, vol. 1, pp. 443-460.

The model developed is applied to a Title I Elementary and Secondary Education Act program in San Francisco.

Stanford Research Institute. *Cost-Benefit Model to Evaluate Educational Programs: Progress Report* by Robert G. Spiegelman. 224 pp. Menlo Park, April 1967.

Progress report on an attempt to develop a framework for the evaluation of educational programs. This will be in the form of a mathematical model that will provide a method for the analysis of benefits derived from the Elementary and Secondary Education Act, Title I program. It is presumed that education is an industry that takes children with certain characteristics and embodies human capital (knowledge) in them.

Swift, W., and B. Weisbrod. "On the Monetary Value of Education's Intergeneration Effects," *Journal of Political Economy.* December 1965, vol. 73, pp. 643-649.

Presents an empirical model for placing a monetary value on the influence of education in one generation.

Weisbrod, Burton A. *Benefits of Public Education: An Economic Analysis.* 143 pp. Princeton University, Princeton, 1964.

Study of the extent to which education provides benefits to people other than students and to others in the community that provides the education. Includes methodology, consideration of various forms of social benefits, quantification, and application to a single case-study community. Chapter 10 summarizes the quantitative findings of the case study and extracts significance for efficiency in resource allocation, equity in educational finance, and implications for public policy.

Wiseman, Jack. "Cost-Benefit Analysis in Education," *The Southern Economic Journal,* July 1965, vol. 32, no. 1, part 2, pp. 1-12.

Discusses limitations of benefit-cost studies as applied to education but accepts the analytical and practical potential of the approach to education as an economic activity. Recommends use of a variety of approaches, such as "market-oriented" studies concerned with the characteristics of the "knowledge industry" and studies concerned with the influence of changes in methods (as distinct from volume) of education provision.

HEALTH

Feldstein, Martin S. "Economic Analysis, Operational Research and the National Health Service," *Oxford Economic Papers*, March 1963,vol. 15, pp. 19-31.

"This paper will first review some of the work in applying economic analysis to public expenditure, which has been done under the rubrics of benefit-cost analysis, operational research, and systems analysis. After a discussion of the growing concern about efficiency in the National Health Service, it will consider the recent interest in operational research for the NHS as an example of the need for the quantitative analyses of operational research to be based upon economic reasoning."

Jahn, J. "The Statistical Design and Analysis of an Experiment to Measure the Effectiveness and Costs of a Health and Welfare Program" *Proceedings of the Social Statistics Section*, American Statistics Association, Washington, D.C., 1965.

Krutilla, John V. "Welfare Aspects of Benefit-Cost Analysis," *Journal of Political Economy*, June 1961, vol. 69, pp. 226-235.

"The author characterizes benefit-cost analysis as the collection and organization of data relevant by some meaningful criteria to determine the relative preferableness of alternatives. Welfare considerations applied to governmental expenditures for resource development are discussed."

Mushkin, Selma J. "Health as an Investment," *Journal of Political Economy*, Supplement, October 1962, vol. 70, no. 5, part 2.

First, compares health and education as types of investment. Second, deals with capital formation through health care and returns to investment in health. "Some empirical work on specific diseases has been done; work has also been done on the overall problems of disease. Although I do not review these specific empirical studies, I attempt to summarize the basic assumptions underlying their estimates and to point to examples of the 'payoff' on investment in eradication of disease."

Neenan, William B. *Normative Evaluation of a Public Health Program.* 74 pp. Institute of Public Administration, University of Michigan, Ann Arbor, 1967.

Applies cost-benefit analysis to Michigan's tuberculosis-control program. Provides criteria for the use of the benefit-cost device and suggests some policy implications.

Packer, A.H. "Applying Cost-Effectiveness Concepts to the Community Health System," *Operations Research*, March-April 1968, vol. 16, no. 2, pp. 227.

"Investigates ways in which concepts of model building and cost-effectiveness can be applied to the health planning process. The problem is described and

methodological implications drawn that recommend large-scale digital-computer simulation techniques. A study of effectiveness measures suggests that the system's basic purpose is to reduce the likelihood that individuals will be in a state of ill health. The proposed measure of ineffectiveness is defined as the expectation of the weighted sum of the population's expected duration of stay in each of *m* disability states. The applicability of this and other measures to specific health problems is also discussed. The paper deals with the problem of estimating costs. Distinctions are made among the various kinds of costs and among the various bearers of the costs."

RAND Corporation. *Cost-Benefit in Health* by A.W. Marshall. P-3274. 18 pp. December 1965.
Reviews the relevant research on the problem of cost-benefit analyses in health (the focus is on the work of economists interested in the economic implications of improved health) and explores the likely requirements, difficulties, and opportunities for cost-effectiveness studies in government health programs. A sample program budget for health prepared by the Bureau of the Budget is included.

Stanford Research Institute. *Alternative Methods of Meeting Mental Health Needs in Rural Areas* by Gertrude D. Peterson and David A. Curry. Prepared for the California State Department of Mental Hygience. SRI Project 5066. 93 pp. August 1965.
Study's purpose was to ". . .determine how local resources within a specific rural area and resources outside the area could be combined to meet mental health needs of the rural population in California." Cost effectiveness of various programs is developed for three counties.

U.S. Department of Health, Education, and Welfare. Office of Assistant Secretary for Programs Coordination. *Maternal and Child Health Care Programs, October 1966.* 113 pp. 1968.
Studies principally cost and effectiveness of various maternal and health-care programs, such as those concerned with vision and hearing defects. Issued by the Office of the Assistant Secretary for Program Coordination, this report is one of a series arising from discussions, suggestions, and comments of the Program Analysis Group on Child Health Care under Department Secretary Gardner.

U.S. Department of Health, Education, and Welfare, Office of the Assistant Secretary (Planning and Evaluation). *Program Analysis: Human Investment Programs–Delivery of Health Services for the Poor.* 135 pp. Government Printing Office, Washington, D.C., December 1967.
Background data on who the "poor" are, their health status, their patterns of receipt of health services, and the major current health programs affecting them. Goals and objectives are proposed, followed by estimates of the costs and effectiveness of suggested programs designed to fulfill these goals.

U.S. Department of Health, Education, and Welfare, Official Program Coordination. *Disease Control Programs: Selected Disease Control Programs.* Government Printing Office, Washington, D.C., 1966.

Cost-benefit study of 14 projected disease-injury control programs.

HOUSING

Davis, D.A., "A Pure Theory of Urban Renewal," *Land Economics*, May 1960, vol. 36, pp. 220-226.

Application of cost-benefit criteria to enable cities to judge the "profitability" of projects. See also comments by M. Schussheim, Land Economics, November 1960, 36: 395-396; N. Lichfield, Land Economics, February 1963, 39: 99-103; D. Davis, Land Economics, February 1963, 39: 103-108.

Mao, James C.T. "Efficiency in Public Urban Renewal Expenditures Through Benefit-Cost Analysis," *Journal of the American Institute of Planners,* March 1966, pp. 95-107.

Presents a theoretical framework for measuring costs and benefits to society of an urban renewal project. Also considers the practical problems of measurement through a case study of the East Stockton, California Urban Renewal Project.

Messner, Stephen. *The Application of a Benefit–Cost Framework of Analysis to Selected Urban Redevelopment Projects in Indianapolis, Indiana: A Case Study of Locally Financed Redevelopment.* Ph D thesis, Indiana University, Graduate School of Business, 1966.

"Considers the validity and effectiveness of benefit-cost analysis, with particular application to selected redevelopment projects in Indianapolis, Indiana. Indianapolis has one of the oldest and perhaps most unique programs of urban redevelopment in the United States. Since 1945, this city has carried on an active slum clearance and redevelopment program without Federal aid or direction."

Page, D. "Urban Renewal," paper presented during Summer Seminar on Systems Analysis, U.S. Bureau of the Budget, August 1965.

Discusses objectives of urban renewal. Analyzes two projects in the light of these objectives and discusses the application of cost-benefit techniques to urban renewal.

Ross, William B. "A Proposed Methodology for Comparing Federally Assisted Housing Programs," *American Economic Review,* May 1967, vol. 57, no. 2, pp. 99-100.

A preliminary review of efforts in the Department of Housing and Urban Development to provide a useful analytic methodology for comparing the costs and benefits of housing assistance programs.

Rothenberg, Jerome. *Economic Evaluation of Urban Renewal: Conceptual Foundation of Benefit-Cost Analysis.* 277 pp. The Brookings Institution, Washington, D.C., 1967.

Stresses residential redevelopment, the original focus of urban renewal. "The view of benefit-cost analysis is in terms of the allocation of national resources. The author illustrates his procedure by applying it to five renewal projects in Chicago. It should be emphasized that his basic concern is not with the before-and-after values of a particular site, but with its relative value in allocation of funds in a region and the nation."

POLLUTION

Baxter, Samuel S. "Economic Considerations of Water Pollution Control," *Journal of the Water Pollution Control Federation,* October 1965, vol. 37, pp. 1363-1369.

"The economics of the disposal of used water is discussed and the following four questions are considered: (1) what are the purposes and uses expected of receiving streams, (2) what benefits and improvements will occur in the stream if a higher degree of treatment is used, (3) what relation exists between the costs involved in, and the benefits derived from, different degrees of treatment, and (4) what is the relation of these costs and benefits to the costs and benefits of other civic programs."

Kohn, Robert E. "Leaf Burning–An Economic Case Study," *Scientist and Citizen,* April 1967, vol. 9, pp. 71-75.

Demonstrates the application of cost-benefit analysis to problems of air pollution abatement.

Ridker, Ronald G. *Economic Costs of Air Pollution. Studies in Measurement.* 214 pp. Praeger, 1967.

Deals with the relationship between ambient-air quality and economic loss and with the development and testing of methods of quantifying this relationship. Three methods for measuring the economic consequences of air pollution are applied in six case studies.

RESEARCH AND DEVELOPMENT

Grossfield, K., and J.B. Heath. "The Benefit and Cost of Government Support for Research and Development: A Case Study," *Economic Journal,* September 1966, vol. 76, pp. 537-549.

"Analysis of the social benefits resulting from the support given by the British National Research Development Corporation (NRDC) to the development of a potato harvester."

Hanson, Robert L. "R&D Decisions by Cost Effectiveness?" Paper contributed to Joint Meeting Operations Research Society of America and the Institute of Management Sciences. 1-3 May 1968, San Francisco, California, 46 pp.

"Mission cost-effectiveness equations may be used to optimize research, development, test and evaluation expenditures according to a criterion of maximum net savings over the system life. The technique is applicable to any applied research which is funded to support a mission. Funds for basic research with absolutely no strings attached cannot be optimized by these techniques."

Steiner, Peter O. "The Role of Alternative Cost in Project Design and Selection," *Quarterly Journal of Economics,* August 1965, vol. 74, pp. 417-430.

"In attempting to find the conditions that can be avoided, limited, or made more manageable in the problem of estimating benefits, the author examines the situations where the cost of an alternative project can substitute for or provide limits to benefit measurement. The basic strategy of this study was to set up a model in which two public projects and two private projects were considered. Then assumptions about the following were varied: what is alternate to what, what combinations of projects are compatible, what institutional rules govern the selection of projects, and what quantities and qualities of services are provided by individual projects."

STATE AND LOCAL GOVERNMENT FUNCTIONS

"Cost Benefit Analysis in Town Planning," *Urban Studies,* November 1966, vol. 3, pp. 215+.

"A methodology of cost-benefit analysis for city and regional planning, which has come to be called 'the Planning Balance Sheet.' It shows how the method can be applied to a particular problem: which of two alternative plans to adopt for the central area of a small town."

Lichfield, Nathaniel. "Cost Benefit Analysis in Urban Development: A Case Study: Swanley," *Regional Science Association Papers, European Congress,* Cracow, 1966, vol. 16, pp. 129-153.

Cost-benefit analysis is applied to the problem of relocating a road through the central business district of a small market town. The method involves a "Planning Balance Sheet," that lists the costs and benefit that will flow to particular sectors of the community from alternative projects. The procedure lays the basis for a value judgment by the decision makers.

System Development Corporation. *Cost-Effectiveness Analysis for the Fire Service: An Overview.* 20 pp. Santa Monica, California, September 1967.

"Examines the technique of cost-effectiveness analysis, including its advantages and limitations, and discusses its potential usefulness to the fire service.

U.S. Advisory Commission on Intergovernmental Relations. *Metropolitan Social and Economic Disparities: Implications for Intergovernmental Relations in Central Cities and Suburbs.* Report A-25. U.S. Government Printing Office, Washington, D.C., 1965.

Theoretical framework for allocating costs and benefits of metropolitan-wide services. Includes ACIR recommendations.

U.S. Advisory Commission on Intergovernmental Relations. *Performance of Urban Functions: Local and Areawide.* Report M-21. U.S. Government Printing Office, Washington, D.C., 1963.

Economic criteria for allocation of urban functions.

TRANSPORTATION

CONSAD Research Corporation. *Design for Impact Studies–Northeast Corridor Transportation Project.* Preliminary Report. Prepared for the U.S. Department of Commerce, August 1965. Var. pag.

Includes proposed methods and techniques of measurement of direct and indirect benefits and costs associated with changes in the regional transportation network.

General Research Corporation. *Systems Analysis of Urban Transportation.* Santa Barbara, California, January 1968.Var. pag.

There are four volumes of this final report of a study performed for the U.S. Department of Housing and Urban Development under Contract H-777. Most of the cost-benefit work is in Volume III *(Network Flow Analysis)* and and Volume IV *(Further Analysis).* Volume I is a summary volume and includes a guide to study organization and to the 44 individual research papers.

Gilbert, Keith. "Economic Balance of Transportation Modes," *Traffic Engineering*. October 1963, vol. 34, pp. 17-25, 50+.

"In this analysis, alternative transportation systems are fitted to the future travel pattern for San Diego, California. The alternate modes are then quantified on the basis of user cost and construction cost. The transportation systems evaluated included a 200-mile system of freeways, a 160-mile system of rail transit, and a 160-mile system of busways (exclusive bus freeways). These modes established the limiting conditions for the range of transportation-system choice. Combinations of these principal modes were analyzed to determine intermediate points. Annual costs were calculated, and an incremental benefit-cost ratio analysis was undertaken."

Moses, L.N., and H.P. Williamson. "Value of Time, Choice of Mode, and the Subsidy Issue in Urban Transportation," *Journal of Political Economy*. June 1963, vol. 71, pp. 247-264.

"This paper reviews techniques that have been used in a particular variety of highway benefit studies. The objective of these studies is to estimate the

value of travel-time savings achieved by improving an old road or building a new one. The theoretical structure underlying these studies is scrutinized, exclusive attention being given to work trips."

National Research Council. Highway Research Board. *Highway Finance and Benefits: Four Reports.* 64 pp. Washington, D.C., 1966.

Partial contents: The measurement of vehicular benefits by G.P. St. Clair and others; a new approach to benefit-cost analysis by Robinson Newcomb.

National Safety Council. *How to do a Cost-Benefit Analysis of Motor Vehicle Accident Countermeasures* by J.L. Recht. Chicago, September 1966.

Among the many possible forms of cost-benefit analysis, three approaches seem to be the most pertinent for evaluation of motor-vehicle accident countermeasures. These three approaches are herein called (1) "complete range analysis," (2) "expected effect analysis," and (3) "break-even analysis."

Perazich, George, and Leonard L. Fischman. "Methodology for Evaluating Costs and Benefits of Alternative Urban Transportation Systems," *Highway Research Record #148–Transportation System Evaluation–Five Reports.* Highway Research Board Publication 1423, pp. 59-71, Washington, D.C., 1966.

Discusses the costs and benefits of given alternative transportation systems for each of three major elements in the community–users, operators, and the community itself.

Speas (R. Dixon) Associates. *Cost/Benefit Analysis for All-Weather Landing System (AWLS) Category II and III.* Final Report, 100 pp. Manhasset, New York, October 1967.

"The study determines the costs and benefits resulting from implementation of category II and category III all-weather systems during the 1967-1980 time period and establishes the optimum practical ground-airborne implementation schedule, including the priority-ranked order for equipping 40 individual airports."

Stanford Research Institute. *A Manual for Conducting Highway Economy Studies* by David A. Curry and Dan G. Haney. 163 pp. August 1966.

"The manual presents data and methods for computing economic indexes of desirability for highway improvement projects. It is intended for highway studies in the United States and in other countries having well-developed economies and road systems and does not cover problems that are frequently encountered in developing countries. It focuses on the effects of highway construction upon users and operators of highways and does not include secondary or indirect effects, such as changes in land values. This emphasis is consistent with current economic theory, which concludes that in developed countries, substantially all net changes in real income and economic welfare caused by highway improvements are covered by the resulting savings in transportation costs (including the value of travel time savings)."

Systems Analysis and Research Corporation. *Air Traffic Growth, Airline Finances and Public Benefits in Relation to the Cost of New Programs to Alleviate Jet Aircraft Noise Near Airports.* 135 pp. Boston, Massachusetts, January 1967.

"Effective new programs for coping with aircraft noise problems around airports will probably involve new expenditures. If such costs are passed on to airline traffic, they will affect traffic growth through price elasticity of demand. A 1-percent increase in fares and rates is estimated to decrease traffic by 1.3 percent; a 5-percent increase would reduce traffic by 6.3 percent. Separate elasticities are estimated by major airline groups: -1.28 for domestic trunkline passengers, -1.6 for international passengers, -1.0 for local service passengers, and -1.5 for cargo traffic."

U.S. Department of Transportation–Systems Research and Development Service, Systems Analysis Division, Systems Effectiveness Branch. *Cost Effectiveness Analysis of Automation of Air Traffic Functions at Radar Terminals* by James E. Luckman and Marjorie B. Halle. 2nd Interim Report, 35 pp. Washington, D.C., July 1967. Official Use Only.

U.S. National Bureau of Standards. *Notes on the State-of-the-Art of Benefit-Cost Analysis as Related to Transportation Systems* by Joseph D. Crumlish. NBS-TN-294, 45 pp. 1 November 1966.

"This review of benefit-cost analysis as a tool for evaluating alternative courses of action describes the technique, discusses a number of benefit-cost studies, and indicates the difficulties inherent in this area of applied economics. The author concentrates on the application of the technique to large-scale transport problems, reviews the literature, and indicates in his conclusions where the technique can be helpful and where there is little chance for its success."

VOCATIONAL TRAINING

Bateman, Worth. "An Application of Cost-Benefit Analysis to the Work-Experience Program," *American Economic Review,* May 1967, pp. 80–.

Attempts to develop an analytic framework for evaluating the work-experience component of the Work-Experience and Training Program and seeks to estimate its potential effectiveness in improving the capability for self support.

Borus, Michael. "A Benefit-Cost Analysis of the Economic Effectiveness of Retraining the Unemployed," *Yale Economic Essays*, Fall 1964, vol. 4, pp. 370-429.

Based upon interviews with 373 Connecticut workers who were involved in retraining courses. (Ph D thesis completed at Yale University.)

VOCATIONAL TRAINING

Committee on Manpower and Economic Development, North Carolina Fund. *Training the Poor: Rationale for a Benefit-Cost Evaluation of MITCE*. 52 pp. Durham, 1967.

The Manpower Improvement Through Community Effort (MITCE) is the first large-scale project designed for the needs of the poor. A benefit-cost analysis of MITCE is important to the proposed reorientation of the proverty program and the Manpower Development and Training Act of 1962 so as to take more account of the rural population. The proposal is summarized and discussed in *Monthly Labor Review*, September 1967, pp. 45-51.

Conley, R.W. *The Economics of Vocational Rehabilitation.* Johns Hopkins Press, Baltimore, 1965.

Deals with economic problems caused by disabilities and economic benefits of vocational rehabilitation.

Levine, A. "Cost-Benefit Analysis of the Work Experience Program," *Welfare in Review*, August/September 1966, vol. 4, pp. 1-9.

Outlines a cost-benefit study of Aid to Families with Dependent Children programs.

Pennsylvania State University, Institute for Research on Human Resources. *An Analysis of the Comparative Costs and Benefits of Vocational Versus Academic Education in Secondary Schools* by Jacob J. Kaufman et. al. 1967. Var. pag.

Prepared for the U.S. Office of Education Bureau of Research.

Stromsdorfer, Ernst W. "Determinants of Economic Success in Retraining the Unemployed: The West Virginia Experience," *Journal of Human Resources*, Spring 1968, pp. 139-158.

"An analysis of the costs and benefits of government-sponsored retraining of the long-term unemployed in West Virginia from 1959 through 1964, based on the post-training experience of trainees."

Therkildsen, Dr. Paul. "Cost-Benefit Evaluation of the Bernalillo County Work Experience and Training Program," *Welfare in Review*, March/April 1968, vol. 6, pp. 1-12.

"Outlines the research project now under way with respect to cost-benefit evaluation of the Bernalillo County, New Mexico, Work Experience and Training program conducted by the New Mexico Department of Public Welfare."

U.S. Department of Health, Education, and Welfare. *An Application of Cost-Benefit Analysis to the Work-Experience Program of U.S. Department of Health, Education, and Welfare.* Washington, D.C., n.d.

Costs were measured as per-pupil expenses for state and federal governments. Both long-run and short-run benefits were covered.

WATER

U.S. Department of Labor. "Cost-Effectiveness Analysis of Manpower Programs," in *Manpower Report of the President,* pp. 219-222. Washington, D.C., 1969.

Describes output of first year and a half of activity of cost-effectiveness analysis of manpower programs in the Manpower Administration of the U.S. Department of Labor, initiated in 1966. First pilot study compares costs and benefits of institutional and on-the-job training under the Manpower Development and Training Act. The second study deals with an illustrative cost-goal analysis in U.S. Employment Service area and was designed to estimate the benefits to the GNP that would result from a dollar of expenditure on Employment Service activities. The third study was an attempt to assess the "costs" as related to the anticyclical objectives of unemployment insurance and of failure to enact the proposed 1966 amendments to the unemployment insurance legislation.

University of Wisconsin, Department of Economics and Institute for Research on Poverty. *Benefit-Cost Estimates for Job Corps* by Glen G. Cain. Report no. 9-67, 51 pp.

"The question examined in this study is 'Does the investment in Job Corps pass the economic test of efficiency?' Alternatively, we ask, 'Does the program earn a rate of return at least equal to some average rate earned by other private and governmental investments?' The best simple answer to this question that this study offers is 'yes,' but there are a number of qualifications that go along with this favorable verdict."

Weisbrod, Burton A. "Conceptual Issues in Evaluating Training Programs," *Monthly Labor Review,* October 1966, vol. 89, pp. 1091-1097.

"Training programs, like other objects of public or private spending, ordinarily involve both benefits (advantages) and costs (disadvantages). This article discusses the forms of such effects in the manpower training area and presents some suggestions regarding measurement methods. The need to evaluate training programs in terms of their effects on efficiency of resource allocation and on the distribution of income is underscored."

WATER

Devine, E.J. "The Treatment of Incommensurables in Cost-Benefit Analysis," *Land Economics,* August 1966, vol. 42, pp. 383-387.

"A simplified problem in budgeting between water reclamation and recreation is used to illustrate the treatment of incommensurables in a cost-benefit analysis. It is assumed that all costs and benefits are exhaustive and certain and that the benefits due to recreation are incommensurable (cannot be measured in the same units) with the benefits (measured in dollars) due to water reclamation. The recreation benefits are not intangible, however, in that they can be measured quantitatively, in units of user-hours." Tables that display the trade-offs involved are presented.

Eckstein, Otto. *Water Resource Development: The Economics of Project Evaluation.* 300 pp. Harvard University Press, Cambridge, 1958.

"Benefit-cost criteria for the evaluation of water resource development projects are developed. Procedures for application of these criteria to various types of projects are given. Historical and political aspects of project selection are discussed."

Hirshleifer, J., J. DeHaven, and J. Milliman. *Water Supply: Economics, Technology and Policy.* 378 pp. University of Chicago Press, Chicago, 1960.

Especially pertinent is Chapter 8 on "Technological Features and Costs of Alternative Supplies of Water."

Marts, M.E., and W.R.D. Sewell. "The Application of Benefit-Cost Analysis to Fish Preservation Expenditures: A Neglected Aspect of River Basin Investment Decisions," *Land Economics,* February 1959, vol. 35, pp. 48-55.

"The conflict of fish-versus-power is discussed in this article as one of the greatest obstacles to river basin development. The authors view this problem in the context of the contribution of fish and power to the total development of a given river basin rather than as two mutually exclusive and discrete alternatives. Attention is given to the economics of fish preservation."

Pavelis, George A., and John F. Timmons. "Programming Small Watershed Development," *Journal of Farm Economics,* May 1960, vol. 42, pp. 225-240.

"Two of the objectives for optimal development of watershed programs are (1) maximizing discounted net returns from watershed resources and (2) allocating development costs equitably among various private or public participants." Discusses their achievement within a comprehensive planning framework, combining benefit-cost analysis and linear programming.

Pyatt, Edwin E., and Peter P. Rogers. "On Estimating Benefit-Cost Ratios for Water Supply Investments," *American Journal of Public Health,* October 1962, vol. 52, pp. 1729-1742.

"Concerned with the relationship of money value to municipal water supply improvements. A simplified approach is presented for ascertaining municipal water supply benefit-cost ratios for underdeveloped regions of the world. The authors' methodology is applied to Puerto Rico as an example."

Stanford University, Food Research Institute. *Benefit-Cost Analysis and Water Pollution Control* by R.S. Hammond. Miscellaneous Publication No. 13, 1959, 95 pp. Stanford, 1959.

Deals with benefit-cost analysis in general and water pollution problems in particular. The work, under contract to the Department of Health, Education, and Welfare, discusses, first, benefit-cost analysis with major attention given to historical development and, second, the water pollution problem and evaluation of investment in pollution control.

Stanford University, Institute for Mathematical Studies in the Social Sciences. *The Nature of Flood Control Benefits and the Economics of Flood Protection* by Robert C. Lind. 104 pp. 12 December 1966.

Technical report dealing with the problems of assessing the benefits from various types of flood protection. Discusses the nature of the benefits from flood protection and relates the various types of benefits to five different measures for coping with flood losses. Develops a theory of land use as it relates to the structure of rents and employs it to develop "the proper measure of benefits from land enhancement." Deals finally with the effects of alternative programs of insurance on the cost of risk-bearing associated with flooding.

MISCELLANEOUS APPLICATIONS

Brooks, David B. "Strip Mine Reclamation and Economic Analysis," *Natural Resources Journal,* January 1966, vol. 6, pp. 13-44.

Cost-benefit analysis and its application to strip and auger mining.

Clinkscale, Robert M., Jr. "Benefit-Cost Analysis Applied to Traffic Safety," *Canadian Operational Research Society Journal,* March 1969, vol. 7, no. 1, pp. 62–.

"This paper examines the usefulness of benefit-cost analysis as a means of making more informed decisions regarding public expenditure for traffic safety programs. No attempt is made to develop actual quantitative estimates of benefits and/or cost of alternative traffic safety programs. But the development of an analytic framework for making such estimates, the identification and measurement of the major components of benefits and costs, and the drawing of conclusions concerning the methodology, research and data collection needs for further progress in applications to traffic safety problems are attempted."

Day, Ralph L. "Optimizing Marketing Research Through Cost-Benefit Analysis," *Business Horizons,* Fall 1966, vol. 9, pp. 45-54.

"Mounting expenditures for marketing research have emphasized the need for better standards and methods of setting research budgets. The cost-benefit model offers an improved technique for planning such expenditures. It deals explicitly with the problem of uncertainty associated with such analysis and relates it to certainty as a norm to arrive at a better method of making decisions about marketing research possibilities."

Enke, Stephen. "The Economic Aspects of Slowing Population Growth," *Economic Journal,* March 1966, vol. 76, pp. 44-86.

Argues that economic resources devoted to reducing population growth are more effective in raising per capita incomes in underveloped areas than are the same resources applied to accelerating production, and estimates the cost of an adequate birth control program.

Fray, Lionel L., Warren G. Briggs, and John R. Russell. *Cost-Effectiveness and Utility Functions for Incentive Structures.* Paper presented before the 29th National Meeting of Operations Research Society of America, Santa Monica, California, 18 May 1966.

This paper first describes the theory by which a buyer aligns his utility with that of the seller, creating the incentive structure. This can be simplified when cost-effectiveness analyses can help relate increments of performance and time (delivery) to dollars of incremental cost. When this approach cannot be employed, a utility function must be developed by other means, such as an iterative comparative preference method. An extensive example of such an application is described using a method that employs a computer to help the decision-maker develop an analytic utility function in three dimensions. The mathematical approach can be extended for analytic utility functions in additional dimensions."

Harris, Roy D., and Roland K. Smith. *A Cost-Effectiveness Approach to Facilities Layout.* Working Paper 67-22, University of Texas Graduate School of Business, August 1967, 25 pp.

Specifically, the purposes of this paper are (1) to explore briefly the general area of production design essential for a background understanding of plant layout, (2) to suggest a systems approach to the facilities configuration problem, and (3) to suggest a cost-effectiveness methodology for evaluating alternate layout proposals from the systems-analysis viewpoint.

Headley, J.C. "Estimating the Productivity of Agricultural Pesticides," *American Journal of Agricultural Economics,* February 1968, pp. 13-23.

"Develops a cost-benefit analysis of pesticide use based on an aggregate production analysis for the 1960s, but concludes that much more analysis and information are needed to evaluate pesticide technology and intelligently form Federal policy."

International Association of Chiefs of Police. *Guidelines for Police Services on Controlled Access Roadways* by R. Dean Smith and D.A. Espie. Var. pag. Washington, D.C. April 1968.

Report prepared for the U.S. Bureau of Public Roads. Chapter 1, "Budgeting and Administrative Decision Making," includes illustrative example of applying cost-benefit analysis to five speed enforcement strategies.

Levine, Abraham S. "Cost-Benefit Analysis and Social Welfare: An Exploration of Possible Applications," *Welfare in Review,* February 1966, vol. 4., pp. 1-11.

Includes selected bibliography.

Little, Arthur D., Inc. *Cost-Effectiveness in Traffic Safety.* Special Studies in U.S. Economic and Social Development Series. 167 pp., figs. 1968.

> "This text is the result of a 1-year study sponsored by the U.S. Department of Commerce to determine the feasibility of applying cost-effectiveness methodology to the pressing traffic-safety problem. A good portion of the book is devoted to cost-effectiveness methodology, per se. Regarding traffic safety, the following subjects are treated at length: collecting, categorizing, and evaluating data; measurements relevant to evaluating program cost and effect and for design of experiments; and accident costs."

Naval Research Laboratory. *The Throughput and Cost Effectiveness of Monoprogrammed, Multiprogrammed, and Multiprocessing Digital Computers.* 136 pp. Washington, D.C., April 1967.

> "A generalized model of a digital computer system with a workload drawn from proffered infinite workload was investigated to determine the factors that affect throughput and cost effectiveness to allow optimization of the system parameters."

Parks, George M. "Risk and Performance Analysis in the Design of Distribution Systems," *Journal of Industrial Engineering,* New York, January 1967, vol. 18, no. 1, pp. 14-18.

> "The objective of this research project is to develop an appropriate transformation between system effectiveness and dollar costs of operating distribution systems. Newly developed techniques for analyzing risk in distribution logistics and computing the cost effectiveness of various distribution-system structures are described."

Peters, G. *Cost-Benefit Analysis and Public Expenditures.* Institute of Economic Affairs, London, 1966.

> Discussion of classic studies with introduction.

RAND Corporation. *Criteria for the Location of Federal Regional Facilities* by A.H. Pascal, H.E. Hausner. RM-4980-EDA, 84 pp. April 1966.

> "Guidelines for use in selecting locations for Federal regional facilities. The study deals particularly with the increases in system cost attributable to establishing a regional facility in a designated economic redevelopment area rather than at the most efficient location in terms of office administration. In the example chosen for detailed analysis, the Pacific Coastal Area, the Small Business Administration has made a reasonable choice of field headquarters location on cost-effective grounds; regional facilities such as these, however, could make a significant contribution to economic advance in depressed areas without substantially affecting agency costs."

RAND Corporation. *Reflections on Satellites for Earth Resource Surveys: Personal Contributions to a Summer Study* by A.H. Katz. P3753, 38 pp. December 1967.

> "A discussion and preliminary cost-analysis showing that an aircraft reconnaissance system is highly preferable to proposed satellite systems

for surveying earth resources. The cost per square mile covered would be one-eighteenth that of the most nearly comparable (but markedly inferior) coverage possible with satellites. Also, aircraft can be easily reassigned as needed and can avoid politically sensitive areas."

Stade, Marinus. "Cost Effectiveness of Water Bombers in Forest Fire Control," *CORS Journal,* March 1967, vol. 5, pp. 1-18.

"The characteristics of forest fires are described mathematically considering wind velocity, resulting fire patterns, and advance rates. Fire fighting tactics during water bombing are discussed and equations developed for drop height, range of water volume and drop density. The cost of forest fires is developed as a function of loss of land value, direct operating cost of aircraft, depreciation of aircraft, and cost of ground forces. A model is developed to compare water bombers on a cost-effectiveness basis. The data are analyzed in a simulation using FORTRAN and a Univac 1107."

Travelers Research Center, Inc. *A Study of the Feasibility of National Data Buoy Systems.* Final Report, 3 volumes and supplement, AD-664 617-21 and AD-665 314, 1009 pp. Hartford, Connecticut, April 1967.

Volume I, Part 1: National Requirements for Marine Meteorological and Oceanographic Data; Volume I, Part 2: Buoy and Buoy Components Data Compilation and Analysis; Volume I, Part 3: A Cost-Effectiveness Evaluation of Buoy and Non-buoy Systems to Meet the National Requirements for Marine Data, Volume II: Cost-benefits for a National Data Buoy System: An Essay. Volume III: Technical Development Plans for the National Data Buoy System; Summary.

U.S. Naval Personnel Research Activity, San Diego, California. *The Feasibility of Deriving a Cost-Effectiveness Formula for Man/Machine Function Allocation* by Marileen Connelly. Research Memo, SRM 67-4, 76 pp. September 1966.

Presents a summary of progress: "A preliminary cost-effectiveness formula is presented with an evaluation of the sources and availability of the data inputs required by the formula. Using the preliminary formula and methodology as a basis for the analysis, it was concluded that adequate measures of variable effectiveness have not yet been developed due to the complexity of the cost-effectiveness formula and methodology and to the lack of accessibility of input data."

Whittlesey, N.K. "Cost and Efficiency of Alternative Land-Retirement Programs," *Journal of Farm Economics*, May 1967, vol. 49, pp. 351-359.

"Costs of alternative land-retirement programs aimed at controlling supply in U.S. agriculture are estimated by applying interregional competition linear programming models to problems of production allocation under conditions of production capacity in excess of that necessary to meet specified demand levels. The crops considered are wheat, the four major feed grains, soybeans, and cotton."

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		GOVT. CLASS: Unclassified
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SUMMARY

A selective and annotated listing of representative studies applying cost-benefit methodology to communications, education, health, and other parts of the civilian economy. Arrangement is by broad category except for bibliographies and applications of a miscellaneous or mixed nature.

KEY WORDS Cost Benefit Cost Effectiveness Bibliography Communications Economic Development Education Health Housing Pollution Research & Development State & Local Government Transportation Vocational Training Water

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